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Study of the Design of a First Generation Community College STEM Learning Community

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Abstract

First generation students attending college have difficulties achieving academic success, engaging with their peers and persisting (Jehangir, 2010); are growing in number on college campuses; and are significantly underrepresented in STEM programs of study. This research examined the role that a STEM focused Learning Community (STEM LC) and student participation in Early College programs with STEM exposure have on first generation student achievement engagement and retention. The purpose of the project was to research and design a framework for a community college STEM LC for first generation students as a means to increase academic achievement and student retention for this vulnerable population. The study involved 18 sophomore and 20 first generation high school students enrolled in an Early College program; 18 first generation college students enrolled in STEM majors as well as a focus group of college faculty and administrators involved in an Early College program. The research confirmed that student interest in STEM subjects waned from middle school to high school. It also revealed that college students enrolled in STEM programs of study did not fully avail themselves of student services. At the same time however, the students expressed interest in participating in STEM focused student services if they were available at the college. Recommendations include the creation of a STEM LC for first generation students at the community college; retention of full time STEM LC and Early College Program Coordinators; and enhancement of the Early College Program to include more purposeful infusion of STEM activities into the curriculum.

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Introduction

This research project explored the influence that Learning Communities (LC) may have on first generation student success and persistence in STEM program areas of study at community colleges. For the purpose of this project, first generation students are those students who are the first in their immediate family (mother, father, siblings) to attend college; LCs are cohorts of students enrolled in a set of linked courses designed to enhance student engagement and academic achievement through collaborative learning; and STEM is the acronym used for the study of science, technology, engineering and mathematics.

Community colleges are designed as open access institutions, and currently enroll over 40% of college students in the country (Jenkins, 2011). The open access policy poses challenges in terms of student success at community colleges as many students are not prepared for college level work for a variety of reasons. According to a 2013 report by the Boston Foundation, only 42% of community college students in the United States graduate within six years. In Massachusetts only 19.5% of students enrolled in community colleges graduate within four years (Complete College America web site). Community colleges have begun to adopt LCs as a high impact educational practice over the past decade as one means to improve student persistence and achievement.

Research Questions

The topic of this research was to better understand first generation student achievement and retention in STEM areas of study at community colleges. The purpose was to research and design a framework for a community college STEM-focused Learning Community (STEM LC) for first generation students as a means to increase academic achievement and student retention for this vulnerable population.

The research project included a review of the literature to identify recent trends and best practices on LCs and first generation student success at community colleges. This research is important because first generation students often lack the social and cultural capital necessary to succeed in college and they face socioeconomic challenges that pose additional stress on their lives (Engstrom & Tinto, 2008; Inkelas, Daver, Vogt & Leonard, 2007). Underrepresented students, including first generation students, have difficulty engaging in non-academic activities at college (Pascarella et al., (2005). This is especially true for non-residential community colleges where students tend to spend their limited time on campus attending classes and studying. The lack of student engagement at community colleges is an important consideration, as research over the past few decades has shown that student success is positively linked to student engagement.

LCs are one of many high impact educational practices designed to improve student achievement and success. A unique aspect of LCs is that they are premised on fostering student engagement, and participation in LCs has been shown to improve first generation student success. The research project used an urban community college in Massachusetts as a case study site for creating an STEM LC for first generation students. The college is interested in increasing enrollment in its STEM-focused programs of study and serves a diverse population including underrepresented students such as first generation students.

The college in this study offers an early college high school (Early College) program with a local urban high school where first generation students take college level courses at the high school for college credit. The program has a part time Director and two part time Achievement Coaches one of whom is based at the high school. Similar to LCs, early college programs have been found to contribute to college student success (Goldrick-Rab, 2007, p. 17; Spradlin,

Rutkowski, Burroughs & Lang, 2010, p. 245). The first two cohorts enrolled in the program (current high school juniors and seniors) received some STEM exposure. The newest cohort of sophomores, recruited in the fall of 2013, was exposed to more purposeful STEM activities. As part of the research project, students involved in the early college program were surveyed to identify STEM awareness and STEM career interests and a focus group of the program faculty and administrators was convened to determine program effectiveness in student achievement and STEM awareness. Another survey group included current, first generation students enrolled in STEM programs of study at the college. These students were surveyed to identify academic challenges and to determine whether they took advantage of student services or became involved in student activities while enrolled at the college.

The college also has an existing LC designed for first year minority or women students to "explore degrees based in mathematics, science or technology." The program which has been in place for 11 years and generally enrolls 20 +/- students per year is intended to operate as, but is not strictly designed as, a cohort model program. Students are required to take three specific courses in the fall semester, one of which (College Success Seminar), they take together and the other two (Composition 1 or College Reading/College Writing and a Math or Science) they take based on their placement. In the second semester the students take another course together (Technical Awareness and Career Exploration). While the program tries to reserve seats in classes so that the students can attend classes together, this is not always accomplished. The program does not include a formal study group and the courses are not thematically linked. The program has a student Club that is involved in fundraising and there are periodic field trips to STEM business and industries. Currently there are two part time achievement coaches that work with the students providing academic assistance and career counseling.

The research project attempted to answer the following questions:

- Are Early College students interested in STEM subjects?
- Does Early College student interest in STEM subjects change from middle school to high school?
- Does Pre-College STEM exposure increase Early College student interest in STEM?
- To what extent did Early College students utilize the Achievement Coach?
- What social and cultural challenges interfere with Early College students' academic achievement and interest in STEM fields?
- Are there any program changes that should be considered to enhance STEM interest/awareness in the Early College program?
- Which STEM subjects did first generation college students find most challenging?
- To what extent did first generation college students utilize student support services?
- What are the best practices for designing a STEM LC to serve first generation students?
- Is there opportunity to enhance and scale up the existing college STEM LC Program?

In summary, first generation students are a growing population in community colleges and other institutions of higher education. These students face many social, cultural and academic obstacles to college persistence and are highly underrepresented in STEM fields. Research has shown that first generation students have difficulty transitioning from high school to college (Pascarella, E, Pierson, C., Wolniak, G. and Terenzini, P., 2004). The literature review that follows demonstrates that student participation in LCs promotes student engagement and creates social communities of peers which increase student success and persistence. LCs, by fostering a sense of community, provide first generation students with a sense of belonging and

through techniques such as collaborative team work and problem solving learning and allow students to gain the skillsets necessary to succeed in STEM fields.

Literature Review

In order to better understand the academic and social issues that impede first generation student success in college, a literature review was conducted to identify how LCs are used to increase student engagement and academic achievement; and to identify a framework for creating an effective community college LC in order to serve first generation students pursuing STEM majors.

First Generation Students

American institutions of higher education are becoming increasingly diverse. Over the past four decades, enrollment of underrepresented students (such as students of color and first generation students) has increased by 40% (Kinzie, Gonyea, Shoup, and Kuh, 2008, p. 1). Despite this increase in diversity, underrepresented students typically underperform in higher education. Evidence suggests that college poses various challenges for underrepresented students and is particularly challenging for first generation students (Inkelas et al., 2007; Jehangir, 2010; Pascarella, Pierson, Wolniak, & Terenzini, 2004; Rendón, 2006).

There are many reasons why underrepresented students have difficulty persisting in college. Kinzie et al. (2008) conducted a literature review to identify factors that affect underrepresented students (which include first generation students, among other groups) ability to succeed and persist in college. The factors identified through their research included: student background and academic experience, institution type, student interaction with faculty and peers, and other influences such as "sense of belonging" and "validation" (p. 23). The authors cited research that showed positive relationships between student engagement in "educationally

purposeful activities" and academic success and persistence. The authors further noted that while practices aimed at increasing persistence such as LCs have been successful and are increasing in number, national data indicates varying participation among underrepresented students. First generation and transfer students, for example, are less likely to participate in LCs. The authors claimed that the participation gaps by underrepresented students in high impact educational practices "…illustrate lingering inequities in the undergraduate experience." (p. 24).

Similarly, according to Rendón (2006), while underrepresented students have access to college, they often lack the cultural and social capital (cultural background and context and social networks) to help them persist in college where barriers to integration and persistence may exist (p. 4). Rendón found that underserved students and in particular, first generation students, lack "family" cultural capital because their parents have not attended college and therefore cannot help their children navigate the system or provide them with strategies necessary to succeed. In other words, first generation students lack the family support systems or the post-secondary education knowledge base possessed by students whose parents have attended college. As Rendón stated, "Once underserved students cross into the college world, they often experience cultural incongruity in the form of alienation, marginalization, and possibly even cultural attacks such as stereotyping and discrimination." (p.4). Rendón, like Kinzie et al. (2008), conducted research that correlated student engagement with student success but she argued that *validation* is a more powerful tool for underrepresented students because validation "asks college faculty and staff to take the initiative in reaching out to students to assist them to learn more about college, believe in themselves as learners and have a positive college experience." (p. 5). Rendón suggested that success for underserved students needs to be "reconceptualized" and concluded by stating:

> To more fully understand success for underserved students requires a deepened consciousness of educational and social inequalities, unspoken assumptions about students that do not seem to "fit" traditional postsecondary institutional environments, and the unique factors that shape the success of underserved students. Success should not be left to chance (p. 24).

Pascarella, Pierson, Wolniak and Terenzini (2004) provided additional insight into first generation student challenges in their analysis of sample data from a federally sponsored longitudinal study, *National Study of Student Learning* (NSSL). This study focused on student experience and outcomes of a representative cross section of 18 four year colleges and universities across the country between 1992 and 1995. The student samples were selected from the NSSL second and third follow up studies. The initial NSSL study was conducted in the fall of 1992 and involved 3,331 students. Follow up studies were undertaken over the next three years with 72.5% of original students responding in the first year, 66.8% in the second year and 65.3% in the third year. The authors found that while there has been significant research regarding first generation students in terms of academic preparation, college transition, and progress and persistence, little is known about their college experience and cognitive/social development while at college (p. 251). The author's analysis found that the level of parental postsecondary education had a significant influence on student college choices and to a lesser degree, the outcomes of college. Similar to the research conducted by Kinzie et al. (2008) and Rendón (2006), they found that socio-economic factors such as work and family obligations prevent first generation students from engaging with their peers and in extracurricular activities and that their inability to participate in student engagement activities limits their social capital.

As a result, first generation students are more likely to leave college at the end of the first year as compared to students whose parents had attended college.

In addition to the socio-economic and cultural factors that interfere with underrepresented student persistence and success, there are also institutional differences in persistence rates. Spradlin, Burroughs, Rutkowski, Lang and Hardesty (2010) conducted research on student persistence for the Indiana Commission for Higher Education. The report examined (among other issues) national research on outcomes of programs designed to improve student success and participation for underrepresented students. The authors cited a longitudinal study conducted by Provasnik and Planty (2008) of college students in their third year which found that nationally, community colleges, which typically have a larger proportion of at-risk students than four year colleges, have lower persistence rates (p. 28). The authors also found that two-year public institutions, because of their higher attrition rates and larger proportion of at-risk students, face more retention challenges than four-year institutions. Yet, surveys of two-year institutions suggest that these colleges are the least likely to employ the most effective student retention strategies.

Learning Communities

As the preceding literature review demonstrated, underrepresented students face barriers to student success for a variety of reasons. Research has identified some promising high impact educational practices to address issues of achievement and persistence for this student population. LCs are one such practice that integrate academic learning as a means to better engage students, to build a sense of community, and to increase student retention. Typically, LCs are offered in the first year of college and are designed to help students adjust and transition

into college by enrolling a specific cohort of students who take the same set of linked courses and meet in groups to discuss topics of common interest (Spradlin et al. 2010).

Tinto (2003) summarized the results of a study he conducted with Anne Goodsell-Love in 1993 for the National Center for Teaching Learning and Assessment on the impact of LCs on student academic and social behavior and persistence. The study involved three institutions of higher education, two of which were community colleges. Using qualitative and quantitative methods of inquiry, the researchers sampled first year students enrolled in collaborative learning programs at the University of Washington, a large residential public university and two urban nonresidential community colleges, LaGuardia Community College in New York City and Seattle Central Community College. The results of that study found that students who participated in LCs tended to create support groups that extended beyond the classroom; became more involved in classroom learning during and after class; persisted at significantly higher rates than students not enrolled in the LC; and the quality of student learning was enhanced (p. 5). Tinto identified three things that LCs have in common that foster student success, *shared knowledge* which is accomplished by requiring students to take courses together; *shared knowing* which happens when the same students are enrolled in the same classes which facilitates student interaction and engagement; and *shared responsibility* where students become responsible for each other through collaborative and shared learning.

Zhao and Kuh (2004) examined the relationships between participating in LCs and student engagement in a range of educationally purposeful activities of first-year and senior students from 365 four year institutions. The authors utilized the National Survey of Student Engagement (NSSE) annual survey of first year and senior students in their research study. The research involved a sample of 80,479 randomly selected first year and senior students who

participated in the NSSE 2002 survey. The average institutional response rate was 41% . The authors used 47 items from the NSSE survey and constructed six scales of student engagement of which three were designed to measure the "quality" of campus environment and three were designed to measure student self-reported learning outcomes. Similar to the other articles summarized above, the authors found that there is a positive relationship between LCs and desired college outcomes. The research found that educationally purposeful activities like LCs are linked with positive behaviors including "increased academic effort and outcomes such as promoting openness to diversity, social tolerance, and personal and interpersonal development." (p. 116). The authors concluded that "participation in some form of learning community is positively related to student success, broadly defined to include enhanced academic performance, integration of academic and social experiences, positive perceptions of the college environment, and self-reported gains since starting college." (p. 132-133). The authors also found that LCs that incorporated active and collaborative learning with complementary academic and social activities increased academic performance and outcomes such as diversity tolerance." (p. 116).

Other research has delved into specific strategies that can be incorporated into LCs to further increase the student success rates. Beaulieu and Williams (2013) analyzed the effectiveness of using "micro strategies" within LCs to increase student retention. Micro strategies are defined as "strategies that can be practiced by faculty and staff who prefer to focus on the pedagogical value of the learning community structure but are nonetheless aware of most institutions' desire to improve retention of all students" (p. 1). For their study, the researchers analyzed the use of micro-strategies at Wataugu College of Appalachian State University, a public university in North Carolina, over a four-year period from 2001to 2005. The micro strategies evaluated included assigning peer academic advisors, student involvement in

committees and other campus activities, weekly faculty/staff meetings, in house writing centers, cultural events for students, service learning integrated into the curriculum, and faculty/student research collaboration. The authors found significant benefit from employment of these strategies and suggested that by building micro-strategies into the framework of LCs, retention can be increased. Similar to other LC research, the authors found that by creating smaller communities within an institution, LC students become more engaged and tend to persist. Because of their small size, faculty and staff involved in such LCs tend to have increased interaction and awareness of students' progress.

Learning Communities and Underrepresented Students

The literature review showed that underrepresented student persistence and achievement benefit when students engage with peers and faculty and when they gain a sense of belonging at their college institutions. The literature also demonstrated that LCs can be used to create a sense of community, encourage student engagement and facilitate academic achievement. As noted in the Kinzie et al. (2008) research, participation in LCs increases retention rates of underrepresented students and "positively affect grades in both the first and last year of college as well as persistence to the second year at the same institution…." (p.555). The authors cited research by others such as Cruce, Wolniak, Seifert, and Pascarella (2006) to demonstrate that student engagement promotes persistence to the second year of college and that higher education institutions should utilize such programs for those "… who start college with two or more "risk" factors – being academically unprepared or first in their families to go to college or from low income backgrounds." (p. 555).

Lardner (2003), in her article *Approaching Diversity through Learning Communities,* described research and practices that have evolved around diversity work including LCs.

Lardner summarized the results of an National Science Foundation supported LC at the University of Texas at El Paso (among other programs in other institutions) designed for students of color that focused on math, science and engineering with the goal increasing student retention. The college is a commuter campus where 82% of the students are Hispanic and 55% are first generation. Lardner reported that the LC program increased the retention rate of Hispanic and first generation student program participants from 55% of the overall student body to 70% for initial program participants and that the 1997 retention rate for students enrolled in the LC was 77% compared to an overall institutional retention rate of 68%. She asserted that "Learning communities can be designed to invite students from under-represented groups into the academy, and to help them stay and be academically successful." (p. 1).

The 2008 Kuh, et al. study, *Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence,* reached beyond a single institution by including 18 four year college and universities, and involving 6,193 students. The institutions were selected to ensure racial and ethnic diversity and included eleven predominantly white, four historically black and three Hispanic serving institutions. The selected colleges also included institutions that were primarily undergraduate; those with graduate programs; and those with doctoral programs. The selected institutions had various percentages of their first year students living on campus ranging from less than 25% to 90%. The research was conducted to determine the relationships between student behaviors/ institutional practices and student success. The authors used combined student records that included information on student background, pre-college academic achievement, student responses to the NSSE and institutional research records including academic and financial aid information, in order to provide a longitudinal record from the time students entered college to the fall of their second year of enrollment.

The study also sought to determine if there was a relationship between race and ethnicity and the effects of student engagement. The major findings of the study were that student engagement in "educationally purposeful" activities such as LCs is directly related to academic outcomes of first year student grades and persistence. Another finding was that student engagement has "compensatory effect" on first-year underrepresented students' retention and grades. "That is, while exposure to effective education practices generally benefits all students, the effects are even greater for lower ability students and students of color compared with white students." (p. 555).

LCs engender a sense of community and belonging which can help underrepresented students achieve success. Brownell and Swaner's (2009) review of literature on high impact practices and student success demonstrated that LCs provide underserved students with a sense of belonging that helps them formulate learning identities. Through their research they found significant evidence that practices such as first-years seminars, LCs, service learning, and undergraduate research and capstone experiences contribute to student success in higher education and are especially effective for underserved students (p. 26). They found that LCs help students transition to college by building their identities as learners and providing a sense of belonging. They also showed that LCs have a positive relationship to educational outcomes including "intellectual development, integrative thinking, civic engagement, and the development of values and ethics." (p. 27). They agreed with Lardner's (2003) suggestion that that LCs be purposefully designed and that students are better served and institutions can better address access and equity issues when LCs are designed to serve students in risk of failure rather than to satisfy faculty interest in collaboration (p. 29). They also found that faculty development which includes activities and programs designed to improve instruction is an important factor in

creating successful LCs and that several key educational outcomes are engendered by LCs including intellectual development, critical/integrative thinking, and civic engagement.

Institutions interested in improving academic success and persistence for underrepresented students through LCs must find ways to increase access to these students who participate in such programs at a lower rate than white students. Lardner's (2003) previously discussed study suggested that LCs should be designed by institutional practitioners with expertise in diversity in order to promote access and achievement for underrepresented students. According to Lardner (2004), "forming alliances with educators who share commitments to making higher education accessible and hospitable for students of color and other historically marginalized groups is critical to this work, even when the practicing of those commitments takes different forms." (p. 11). Inkelas and Weisman (2003) also found that one of the problems with LCs is the "selection effect." Students who participate in these types of programs generally choose to do so and they usually are students that exhibit aspirations and qualities that result in academic and social success. LCs can facilitate academic success by offering courses that underrepresented students, who might not be as prepared as their white counterparts, may struggle with. By offering such courses as part of LCs, underrepresented students are able to get support from faculty and fellow students involved in the LC.

According to Rendóns (2006) study, many underrepresented students do not know how to become engaged and that faculty interested in creating LCs and/or increasing the number of underrepresented students in LCs must become actively involved in institutional recruitment efforts. "Until learning community practitioners and diversity practitioners collaborate to change the academic culture in and out of classrooms, students of color, first generation students and women will continue to achieve at levels that are disproportionate to their presence in the

general population." (p. 9). Kuh et al. (2008) reached similar conclusions based on their research and research done by others that higher education institutions must create avenues for students to become educationally engaged, especially students with risk factors such as underrepresented students. The authors suggested that conscious efforts must be made to recruit underrepresented students into LC programs that are specifically designed to address the needs of this vulnerable student population.

Conclusion

The review of the literature showed that underrepresented students, including first generation students, have a lower persistence rate than their white peers and that certain educational practices such as LCs can have a positive impact on underrepresented student achievement and retention. The literature suggests however, that LCs need to be "purposefully designed" in order to achieve expected outcomes. Toward that end, educational leaders at intuitions of higher education will need to be mindful about who their LC programs are intended to serve and be proactive in identifying actions needed to accomplish the intended outcomes. Identification of the desired student body as well as high quality curricula, student engagement and collaborative activities are critical components of purposefully designed and effective LCs.

As Tinto (2003) noted, LCs are not the "magic bullet." The research shows that LCs certainly help some underrepresented students persist in college but other actions are needed to address the success of underrepresented students. As Kinzie et al (2008) noted, "Students attending institutions that employ a comprehensive system of complementary initiatives based on effective educational practices are more likely to perform better academically, be more satisfied, and persist." (p. 32). Institutions of higher education committed to the democratic ideals of

diversity and retention of underrepresented students must also pursue other pedagogical and student service/student life practices to complement LCs in achieving these goals.

Research Project Plan

This research project included a needs assessment with an implementation response for first generation community college students in STEM-focused areas of study. The project involved a pragmatic research methodology using mixed method research that included the data collection steps described below. The pragmatic research paradigm was used as it allowed the research question to be addressed using surveys and a focus group of affective parties for data collection and analysis to identify possible solutions to the research problem of academic achievement and persistence of underrepresented students in STEM majors (Mertens, 2010).

Data Collection

For this project, data were collected at a public urban community college and an urban high school located in Massachusetts. The data collection involved several methods including a specific access request for student data at the community college, design and administration of surveys of college and high school students, and convening a focus group of college faculty and staff involved in the Early College program.

Three different groups were surveyed as part of this research project. Two of the groups involved high school students enrolled in an early college program where students take college level courses at the high school for college credit and receive some STEM exposure. These students were surveyed to identify their current and future interest in STEM areas of study and to determine whether or not their participation in the Early College program affected their interest in STEM fields. The third survey group involved first generation students majoring in STEM

disciplines at the college. These students were surveyed to identify academic challenges and student engagement.

The first survey group (Wave 1) was a new 2013/2014 Early College sophomore cohort that was exposed to more purposeful STEM activities. This group was surveyed twice, once in the fall when they first enrolled in the program and then in the spring. The purpose of the surveys was to identify STEM interest and to determine if such interest increased through program participation over time. The second survey asked the same questions as the first survey but included additional questions related to the program Achievement Coach and GPA.

The second survey group (Wave 2) involved the first cohort of students to enroll in the Early College program who were in their senior grade at the high school. The seniors were asked most of the same questions as the sophomores with additional questions regarding their college choices. The students were also asked if they utilized the program Achievement Coach and if so, whether they found this service valuable.

The third survey group (Wave 3) involved first generation students enrolled in STEM-focused programs of study at the community college. The students were identified for participation in the survey by the college's Institutional Research Department. All first generation students majoring in STEM Program Areas of Study were requested via email to participate in an online survey. The colleges' Institutional Research Department assisted in the survey data collection and provided anonymous results. The survey asked participants to identify academic challenges they had encountered, which, if any, student services they utilized, and their involvement in extracurricular activities. Students were also asked to consider whether or not they would participate in student support services not currently offered at the college such as a STEM LC, peer mentoring, and STEM Study groups.

Finally, a focus group of college faculty and administrators involved in the Early College program (Wave 4) was convened to identify best practices, lessons learned and potential program improvements. Participants were also asked to discuss the challenges of introducing purposeful STEM activities into the Early College curriculum. Two interviews were also held with the Program Director of the college's existing STEM based LC.

Findings

The following section presents the findings of the data collected through the surveys and focus groups. The results of each survey and focus group are presented separately.

Early College Student STEM Interest/Awareness

A total of three surveys were administered to high school students enrolled in the Early College program. Two surveys were administered to the sophomore class (Wave 1) and one survey was administered to the senior class (Wave 2). The sophomore class was a new entering cohort of the program and was comprised of 18 students including 11 females representing 61% of the cohort, and 7 males. The senior class was the first cohort to participate in the Early College Program and was comprised of 20 students including 3 males and 17 females (85% of the cohort).

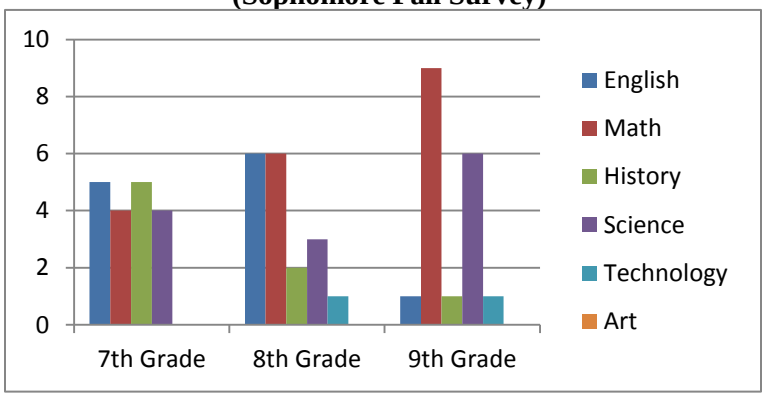
Wave 1: Sophomore student surveys. For the sophomore class, one survey was administered in the fall of 2013 and a second survey was administered in the spring 2014. Both surveys were administered online while the students were present on the college campus. All the students participated in the fall survey and 16 of the 18 students or 88%, participated in the spring survey. The spring survey contained the same questions as the fall survey but also included additional questions regarding GPA and the use and perceived benefit of the Early

College Achievement Coach. The survey and raw data results for the sophomore surveys are found in Appendix A. The results are described below.

Sixty seven percent (67%) of the fall respondents and 63% of the spring respondents were female. In both surveys, all but one student reported attending the same middle school prior to high school. Ninety four percent (94%) of students in the fall survey and 100% of students in the spring survey intended on going to college.

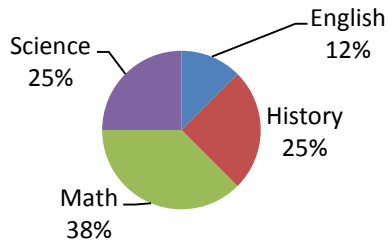
Student interest in STEM subjects. In the fall survey students were asked which subject they were most interested in in grades 7, 8 and 9.

Table 1, Subject Interest by Grade
(Sophomore Fall Survey)



As shown in Table 1, student interest in middle school subjects changed from a fairly uniform student interest in all subjects in grade 7 to a notable increase in student interest in the STEM subjects of math and science by grade 9. Math was listed as a favorite subject by only 22% of students in the 7th grade but increased to 50% by the 9th grade. Similarly, science was listed by 22% as a favorite subject in 7th grade but increased to 33% by 9th grade.

Chart 1
Favorite Subject Sophomore Year
(Sophomore Spring Survey)



In the spring survey, the sophomores were asked to identify their favorite subject. As shown on Chart 1, a large percentage of students reported math as being their favorite subject.

Table 2, STEM Subject Interest
(Sophomore Fall Survey)

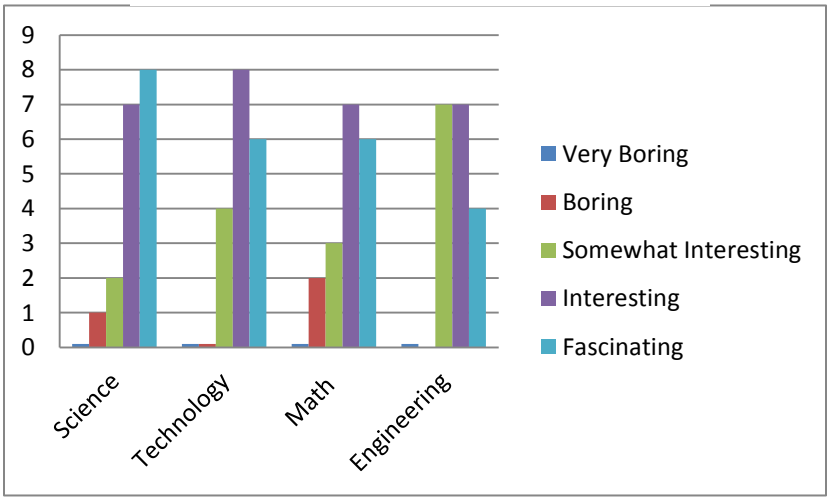
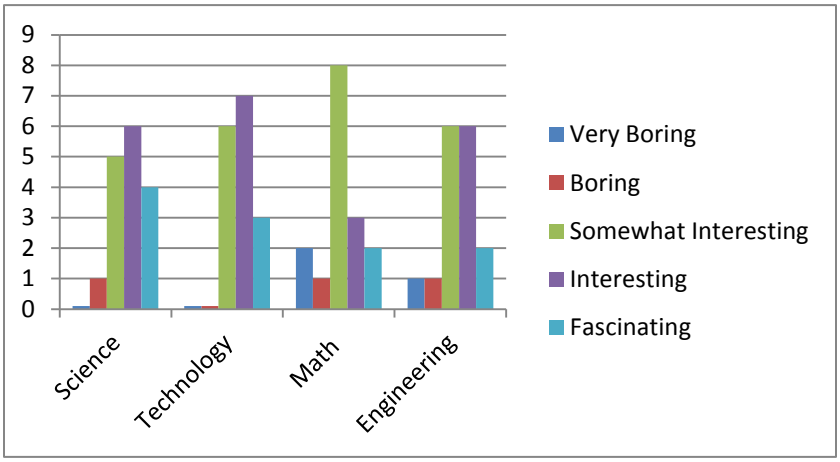


Table 3, STEM Subject Interest
(Sophomore Spring Survey)



Sudent interest in math decreased hoever, over the academic year as shown in Tables 2 and 3. In the fall survey, students found STEM subjects to be more interesting or fascinating than they did in the spring survey where student fascination with math and science decreased considerably.

Table 4, Comfort with STEM Subject
(Sophomore Fall Survey)

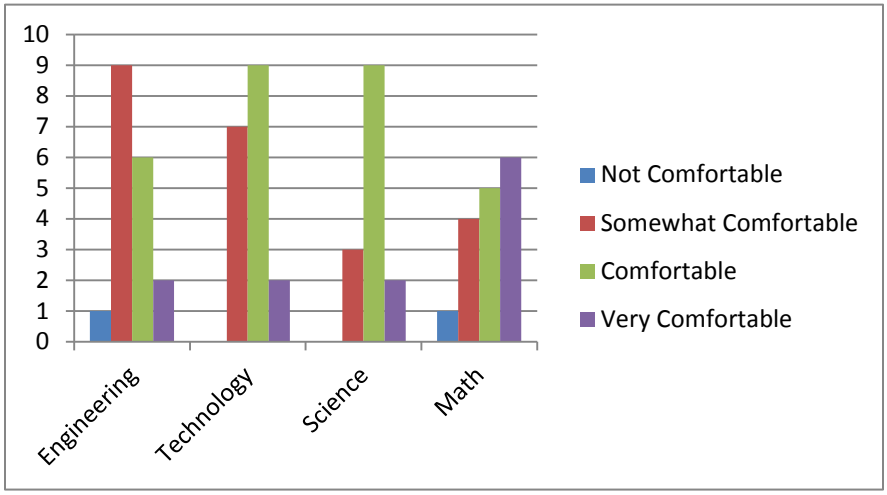
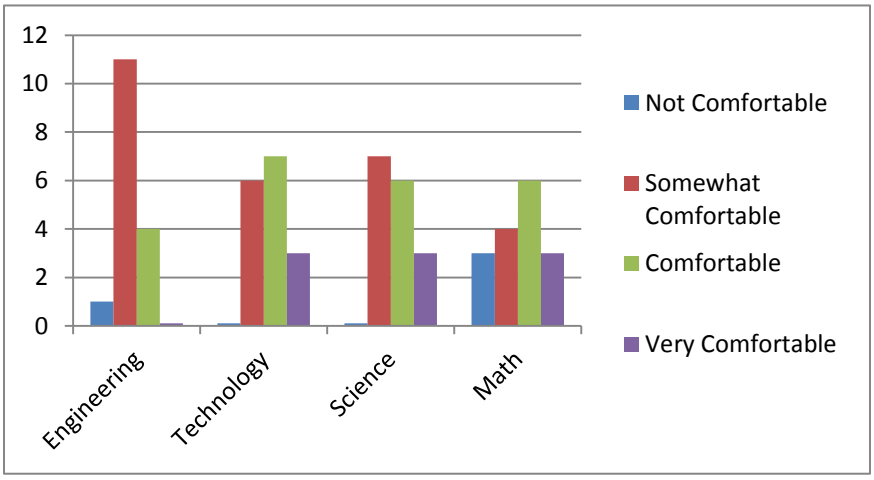


Table 5, Comfort with STEM Subjects
(Sophomore Spring Survey)



As depicted in Table 4, in the fall survey, most students reported being somewhat comfortable or comfortable with STEM subjects (just over 72%) as opposed to those who reported being very

comfortable (24%) and not comfortable (just under 3%). By the spring survey, students who reported being comfortable in all subjects except for math declined. The number of students that reported being uncomfortable in Math increased in the spring however, those reporting being very comfortable in math decreased. In science, while those reporting being comfortable declined over the academic year, this decrease was offset by an increase in students reporting being somewhat comfortable and very comfortable in that subject. Similar to student interest, student comfort level with STEM subjects appears to have decreased from the fall to spring except in Engineering.

In the fall survey, 94% of students indicated they intended on going to college while 6% reported being unsure. In the spring survey 100% of the students indicated they intended on going to college. Ninety percent (90%) of those students of who intended to go to college planned on majoring in STEM subjects in the fall survey with the majority (56%) identifying science as their preferred program of study. In the spring survey, 100% of the students intended to major in STEM subjects with science again being the preferred program (44%) followed by math (31%).

Table 6, STEM Career Interest
(Sophomore Fall Survey)

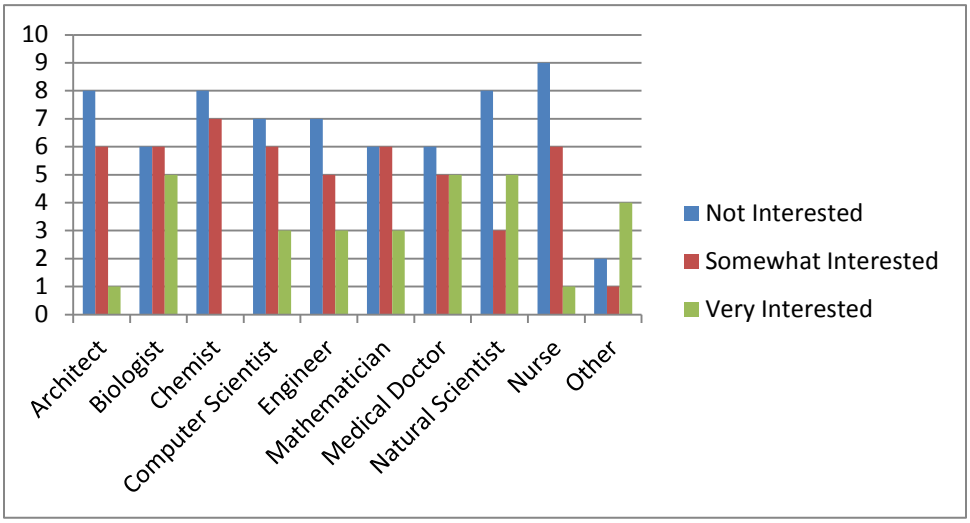
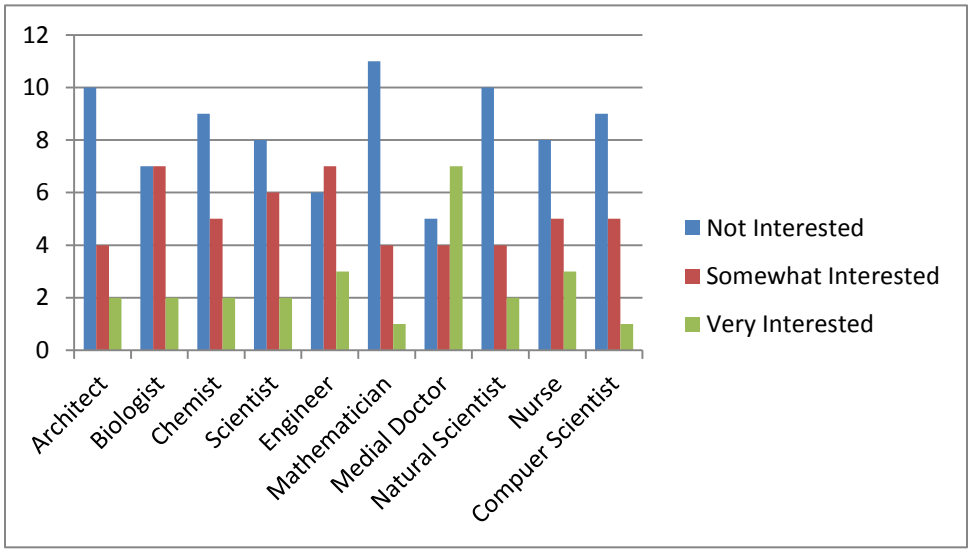


Table 7, STEM Career Interest
(Sophomore Spring Survey)



Student interest in STEM careers and awareness of STEM skills. As shown in Tables 6 and 7, student career interests included STEM and non-STEM careers in both the fall and spring surveys. In the fall survey, students reported that their career interests were as follows: Biologist receiving the highest ranking followed by Artist, Medical Doctor, Computer Scientist and Mathematician. Teachers, Writers and Nurses received the lowest scores. Student interest in STEM Careers also changed during the academic year. In the spring survey, Nurse received the highest combined rank of very interested/ somewhat interested followed Medical Doctor and Scientist. Interestingly, Medical Doctor received the most "very interested" responses (43%). All of the non-STEM subjects received very low rankings as did Architect. Most fall survey respondents had a good understanding of the skills required and used in STEM fields such as problem solving, teamwork, creativity and Mathematics with the following notable exceptions:

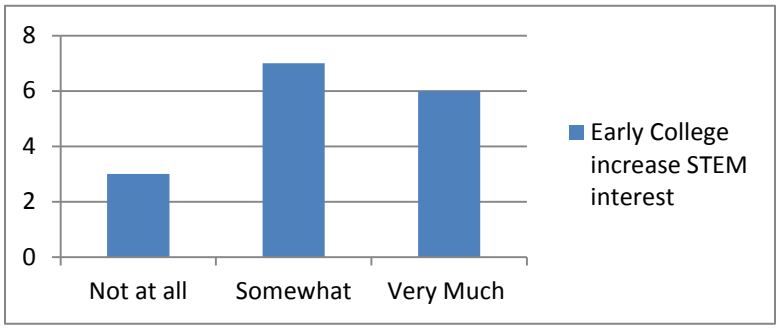
- 34% did not agree that scientist sometimes try to disprove their own theories
- 22% did not understand the difference between scientific theories and fact
- 16% felt that math is not creative
- 16% did not think that people use technology to problem solve.

These responses changed somewhat in the spring survey as noted below:

- 31% did not agree that scientist sometimes try to disprove their own.
- 6% did not understand the difference between scientific theories and fact (a significant improvement from the fall survey).
- 38% felt that math is not creative (a significant increase over the fall survey).
- 13% did not think that people use technology to problem solve.

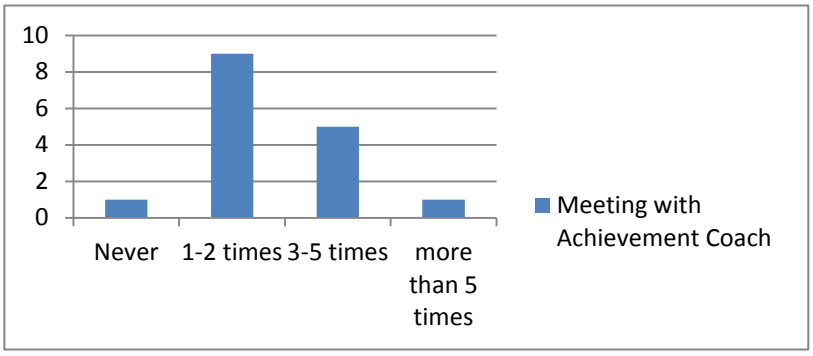
As noted, the spring survey included some additional questions regarding GPA and the use of Achievement Coaches. More than half of the students reported a GPA of 3.5 or higher and only one reported a GPA below a 3.0. The average reported GPA was 3.15.

Table 8, Early College Relation to STEM Interest
(Sophomore Spring Survey)

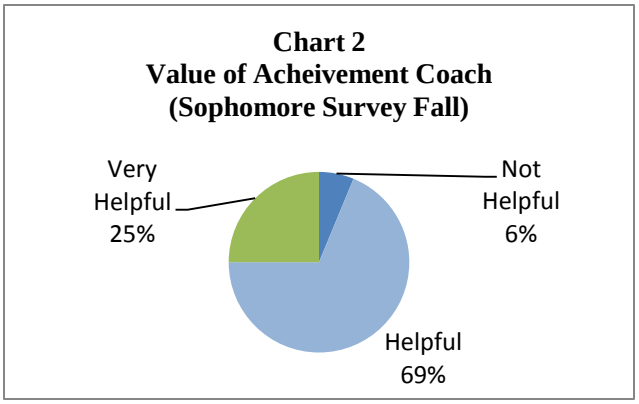


As depicted on Table 8, most students felt that the Early College program increased their interest in STEM with 37% reporting such interested increased very much.

Table 9, Meeting with Achievement Coach
(Sophomore Spring Survey)



More than half the students had met with the Achievement Coach between one and two times since enrolling in the program and only 6% met more than five times (see Table 9). Only one student responded never meeting with the Achievement Coach.

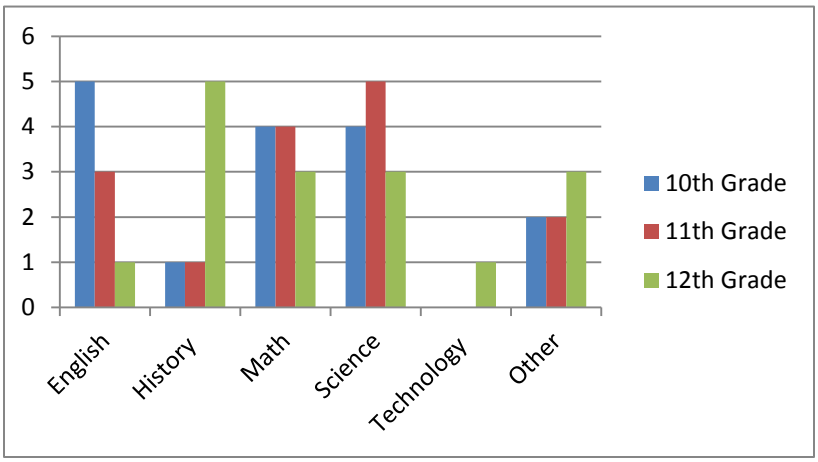


As shown on Chart 2, most students found the meetings with the Achievement Coach to be helpful (69%) or very helpful (25%).

Wave 2: Senior student survey. A survey was administered to the Early College program senior high school students (Wave 2) who had been in the program for two years (see Appendix B for Wave 2 survey and survey raw data results). The survey was administered on line and in person. The survey was similar to the Wave 1 surveys with the addition of specific questions regarding some of the purposeful STEM activities students were exposed to, their plans for college, and their intent on enrolling in STEM majors at college. Of the 20 students enrolled in the senior class cohort, a total of 16, representing 80% of the cohort, participated in the survey. The majority of students who participated in the survey (87.5%) were female which is reflective of the 85% female representation in the cohort. All students but one attended the same middle school prior to high school. All of the students intend on going to college of which 14 (87.5%) plan on majoring in STEM subjects with science being the most prevalent reported subject (43.8%).

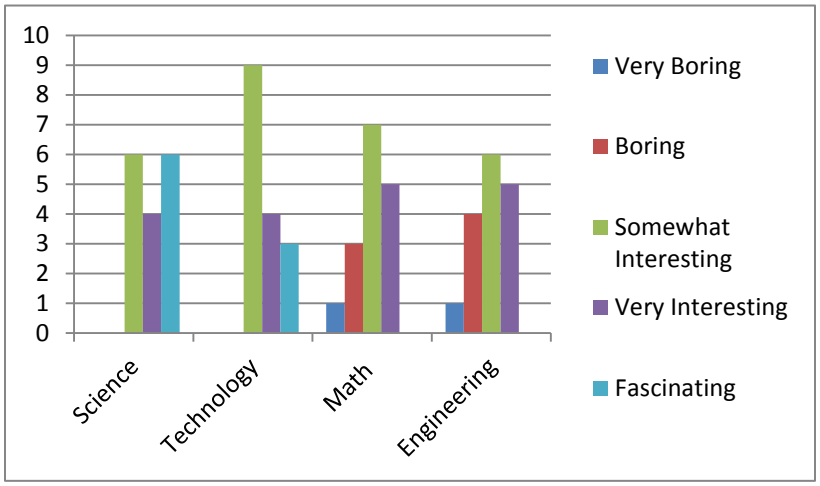
***Student interest in STEM subjects*. S**tudent interest in various high school subjects changed from grade 10 to grade 12 with English being the favored subject in the 9th grade followed by science.

Table 10, Subject Interest
(Senior Survey)



As depicted Table 10, science was favored by students in the 11th grade followed by math. In the 12th grade; history was favored followed equally with math and science.

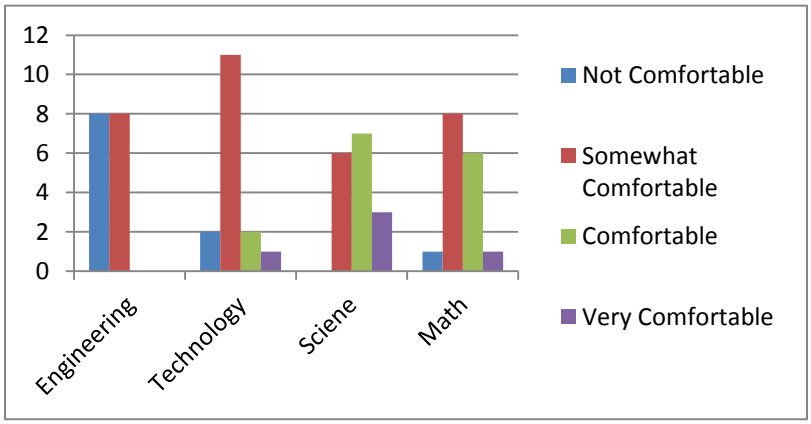
Table 11, STEM Subject Interest
(Senior Survey)



Interestingly, while the sophomore cohort reported finding the subjects of science, technology, math and engineering as interesting or fascinating (combined average of 74%), only 42% of

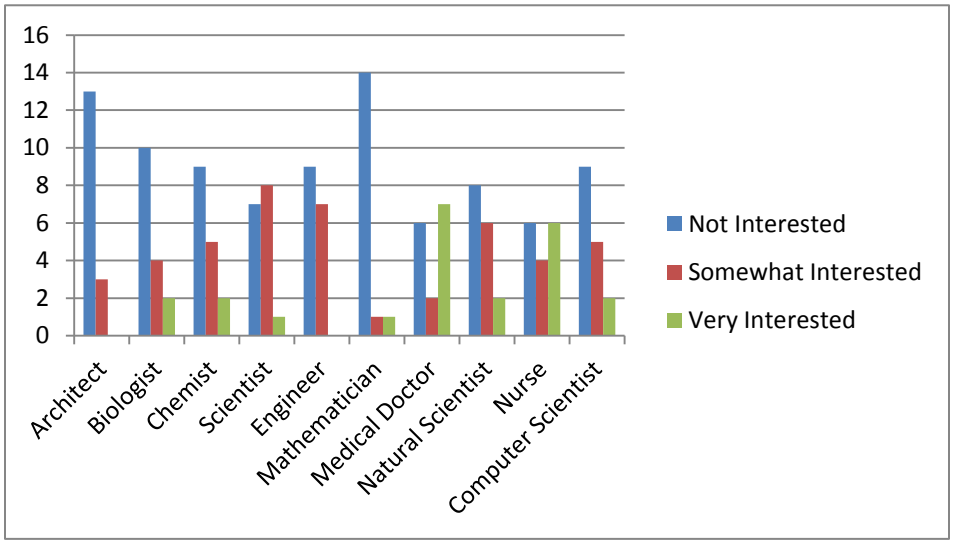
seniors reported the same level of interest and 14% of seniors found the subjects boring/very boring as compared to only 4% of the sophomore cohort (see Table 11).

Table 12, Comfort with STEM Subjects
(Senior Survey)



A slightly higher percentage (75%) of the seniors reported being somewhat comfortable/ comfortable with STEM subjects (see Table 12) as compared to 72% of sophomores but only 7.8% reported being very comfortable (as compared to 24% of sophomores) and 17.9% not comfortable (as compared to 3% of sophomores) with STEM subjects.

Table 13, STEM Career Interest
(Senior Survey)



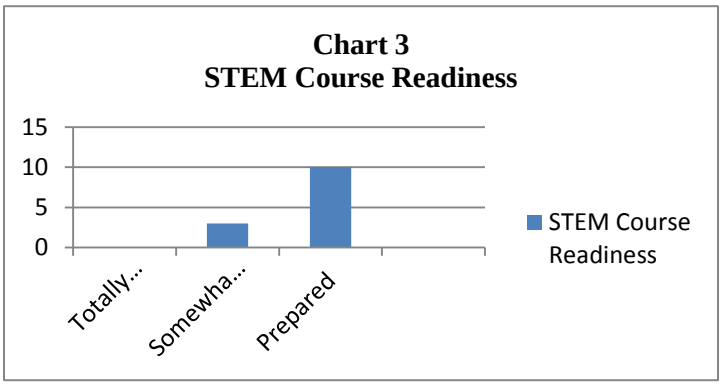
Student interest in STEM careers and awareness of STEM skills. The senior students, like the sophomores, had career interests that included STEM and non-STEM careers as depicted on Table 13. Medical Doctor received the highest combined ranking followed by Nursing and Mathematician. Architect and Biologist received the received the lowest scores. The low score for Biologist contrasts with the sophomore fall survey where biologist received the highest rating. Again, similar to the sophomores, students had a good understanding of the skills use in STEM careers.

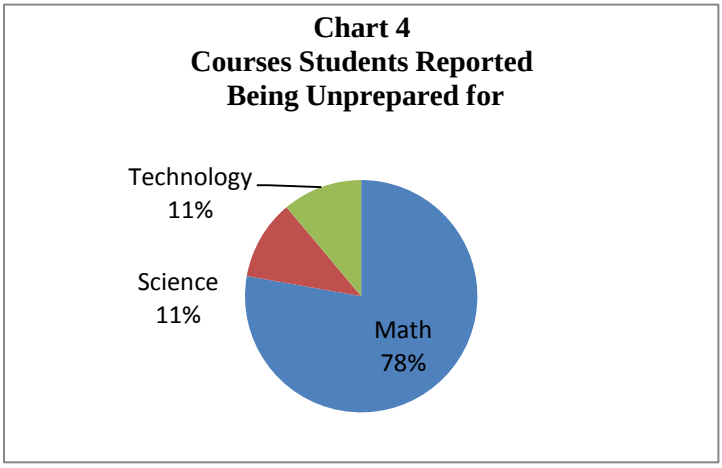
First Generation College Students Enrolled in STEM Majors (Wave 3).

First generation students majoring in STEM subjects at the community college were also surveyed (Wave 3). See Appendix C for Wave 3 survey and survey raw data results. As of January 2014, the college had 520 first generation students enrolled of which 167 (32%) were full time and 353 were part time students. Just over ten percent of those students (56) were enrolled in the colleges STEM program areas of study. An online survey was sent to the 56 students enrolled in STEM majors. Fourteen students (26%) responded to the survey, of which 62% were female.

The survey was different from the surveys administered to the high school students and sought to gain student information on STEM major, experience in STEM programs, use of existing student services, plans for transfer to four year institutions, intention to pursue STEM careers, and interest in participating in STEM focused students services not currently available at the college. All but one of the participants (98%) responded that they had not been involved in any of the fourteen student clubs/activities that were listed in the survey which included some STEM subject clubs. All but one of the students was enrolled in an Associate degree program of which 8 were transfer programs and the most highly enrolled program was Environmental

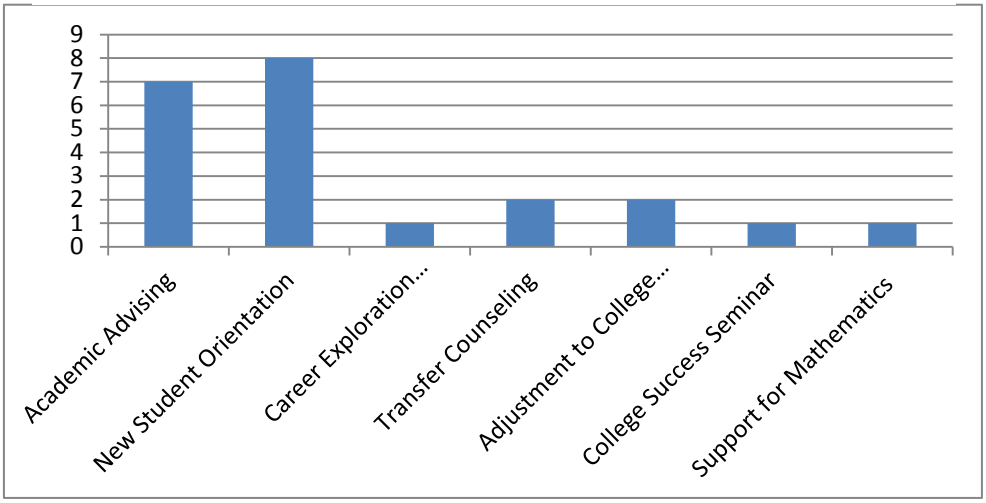
Science. More than half of the students (54%) indicated they planned on transferring to a four year college which closely matches the number of students enrolled in the transfer programs. Participants identified Salem State University, UMass Lowell and Johnson and Wales as possible transfer college choices.





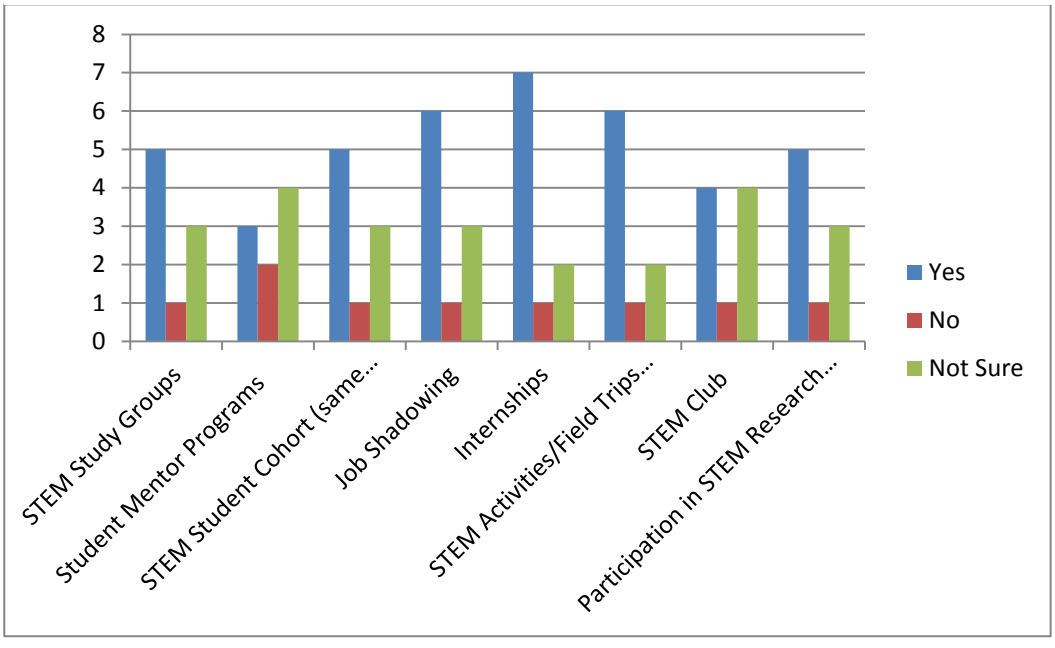
Most students reported that they were prepared in general for the STEM colleges courses they enrolled in while at the college (see Chart 3). Sixty four percent (64%) of students responded to a question that asked about their academic preparation for math, science and technology courses. As depicted in Chart 4, of those students, 78% responded that they were not academically prepared for math courses.

Table 14
Student Participation in Student Services



In general students took advantage of the various student support services offered at the college. However, as shown in Table 14, of the eight services listed only orientation (35%) and academic advising (32%) were used at a moderate level while the others were not well utilized. Of those who participated in orientation, 50% reported that the quality of orientation as good and 57% of those who used academic advising reported the quality of the service as excellent. Smaller percentages reported taking advantages of other services such as career exploration counseling, transfer counseling student success seminar, tutoring and support for mathematics.

Table 15
Student Interest in Participation in STEM-related Student Services



The survey also asked students if they would take advantage of certain STEM-related student services if they were available at the college. As depicted in Table 15, most students reported that would take advantage of such support services if they were available. Most interest was expressed for job shadowing and internships (64%) followed by STEM study groups, student mentor programs and STEM student cohorts.

Early College Focus Group (Wave 4)

A Focus Group of Early College staff and faculty was convened to discuss the role of STEM exposure and purposeful STEM activities in the program. Of the seven people invited to participate, four attended the focus group, two (one who moved out of state and the other who had a conflict with the meeting time) responded to the questions in writing and one did not participate. An agenda was provided to participants in advance of the meeting (refer to Appendix D for the focus group protocol).

The group was asked to consider several questions related to first generation students and STEM including: the unique challenges faced by first generation high school students; the value of STEM education in high school; student use of the Achievement Coach; the program role in fostering student engagement and student interest in STEM subjects; and the challenges of incorporating STEM activities into the curriculum. The group was asked to identify any changes that might enhance the Early College program and what if a STEM LC at the community college would benefit first generation students. The discussion at the focus group meeting was facilitated and recorded. Immediately following the meeting a transcript was prepared and later coded and analyzed to identify common themes. A note taker was also present at the meeting.

First generation student social, cultural and economic challenges. When asked what unique challenges first generation students face in their educational pursuits, most of the

participants were very aware of and were able to cite specific examples regarding students' social and cultural challenges. As articulated by one participant, first generation students are challenged in part because the "broader world is not necessarily within their reach or at their doorstep." Students also encounter peer pressure which can interfere with their commitment to succeed in the program. An example of negative peer pressure was provided by a participant who described how a boyfriend of one of the female students was angry with her because she was being "whitewashed."

The group also discussed the delicate balance they must exercise in considering the student needs in the context of family culture. As one participant explained, "Family comes first, and is certainly the priority, including where the student intends on going to college." An example of these conflicting values was given by a participant who described a meeting where a mother of a student expressed her anger that another one of her sons applied to and received a scholarship at a college out of state. She was incredulous and upset that that her son "had a nerve to apply to an out of state school, what was he thinking?" The mother did not let him enroll.

Family economic pressures also affect student engagement and performance. Many students have to work to help support their families and this limits their availability for after school support and/or activities. As one participant explained, "For some, work is essential for the family's economic well-being." To illustrate the impact of these economic pressures, the participant described a family meeting held for a student who was working three jobs and who was beginning to lose track academically. Luckily, the meeting was effective; the student gave up two of the jobs and her academics "improved dramatically." As another put it, "Things we take for granted aren't always available to them." Several participants discussed the issues involved around being the first in the family to attend college. As one stated, "Not having had

parents who have been through the process before, the process of applying to college may seem confusing or even daunting / intimidating".

These comments and examples support the research regarding the importance of faculty and administrators understanding the unique social and cultural perspective of first generation students and how the lack of family cultural capital can contribute to poor academic achievement.

STEM education and student preparation. When asked about the importance of STEM education, most participants agreed it was important in today's world especially for these students. As one noted,

> STEM education is very important because that is where a bulk of our future jobs will be in these fields. These fields will increase earning potential as well. The skills needed for these fields require critical thinking and a basic understanding of how things work.

Concern was expressed that low-income students do not have the same academic opportunities in STEM areas as others. As one participant stated, "Low income students don't have the same educational opportunities; there is not a level playing field in terms of STEM opportunities or exposure. They are late in the game for STEM." All the participants agreed that the student math preparation is inadequate and this is of great concern especially for students who intend on pursuing STEM majors in college. An example of a hardworking student was given to illustrate the effect of this issue on student achievement.

> One student found that he really enjoyed engineering and decided that he wanted to be an engineer. Even though he worked really hard and took extra math classes, he was too late in the game due to inadequate preparation in middle and high school. He tried to get into an engineering program but was unable to do so. He will be successful however.

As these comments reveal, first generation students often come from poorly funded school districts that may not have sufficient resources which can result in social and educational inequalities graduating students who are underprepared for college.

The difficulty of effectively integrating STEM into the curriculum was also discussed. As one participant noted, technology is expensive and, as noted earlier, several responded that many students are not prepared in math. Their perception was as follows:

> We are trying to catch up. We have students who would benefit from being in a STEM scholars program. We have had some discussions of creating an after school club or working with the school district to develop a more intensive STEM course for some students.

Other participants talked about the importance of time on task and ensuring that STEM activities do not unduly interfere with student academics.

> We need to be careful about taking students anywhere out of school during the day, not all teachers are supportive, not always helpful, and it is complicated when they are at the high school. Much easier in the summer, they are captive, easier to maneuver, in college system.

One explanation given for the difficulty of introducing STEM integrated activities is the lack of time in the high school schedules. This participant related the following:

> The high school day is packed. There are enormous pressures on teachers, students, everyone to make up deficiencies and increase opportunities. It is very difficult to introduce anything new in any way. We have very limited programming during school year.

While participants agree that STEM education is very important, the high school students are generally underprepared in math. There is also little opportunity to enhance student interest in STEM subjects due in large part to the scheduling barriers that prevent integrating purposeful STEM activities into the curriculum.

Student support services. The Early College program in this study features the use of Achievement Coaches who monitor student progress and provide academic, social and career support and advising for the students, one of whom is housed at the high school. The Achievement Coaches also work collaboratively with the principal, guidance counselors, curriculum specialists, department chairs, high school teachers, the community college faculty

and staff to conduct initial orientations/assessments for students in Early College High School. While many students take advantage of the service, the students who are struggling academically often do not. Because the high school is on a seven day rotating schedule that changes weekly, the Early College students do not take courses as a cohort and it is difficult at times for the staff to track them down. Several participants discussed the need to create a summer bridge program to help students transition into college. Others identified the importance of continuing to have a relationship while the students are in college. One participant suggested that the program should "keep in touch with the students beyond high school, maybe offering summer activities or activities over Christmas/spring breaks when many of them would be home from college. Ongoing mentorship would be a great idea too."

A faculty member of the focus group felt very strongly that a college STEM LC would help Early College students successfully transition to and persist in college, and others agreed. This faculty member recounted the following enthusiasm: "Yes! From teaching many different science courses over the past 10 years I see a very strong correlation between the development of study groups and course completion/success." Another participant agreed that they need to plan for and consider the students path to college even after they complete the Early College program. She explained:

> We should be thinking about what they have now but what do they need in college? What do they need to be successful – how to use angel, a platform etc. Some don't have internet at home but they will have it in college. We need to think about what they will need.

Incorporating research into a STEM LC was also supported by at least one faculty member who suggested:

> "Incorporating research into the learning community would be a phenomenal opportunity. I really like the research opportunity. For STEM which is challenging, people are starting sometimes from behind. I think it would be extremely helpful."

Provision of a summer bridge program leading to a college STEM LC would facilitate student engagement, deepen the cohort model, provide students with social capital and contribute to persistence into the second year of college. Faculty interaction and feedback would give first generation students "validation" and help them believe in themselves while providing a positive college experience.

Student engagement and success. There are many factors that impede first generation student success including the lack of engagement. All participants agreed that cohort models increases student engagement. Student engagement was also viewed by one participant as a means to "avert" adverse peer pressure from being an achiever. Interestingly, the same participant saw a notable difference in the level of engagement when the students where physically at the college campus during the summer session versus at the high school during the academic year. "While they acknowledge and interact with me at the college, I am a complete stranger to them when we are back at the high school". Participants suggested that experiential learning including hands on activities, field trips, and speakers are the mechanisms that engendered student engagement and that students appeared to enjoy these activities much more than their classroom experiences. This is not surprising as research shows that student engagement and purposeful activities help students create learning identities and improve student success and academic achievement (Kuh, 2008).

Discussion of Findings

Several important findings of the research and their implications are provided below.

Early College student interest in STEM subjects. The results of the student surveys support research on student interest in STEM. As other research has demonstrated, student interest in STEM subjects appears to have waned after middle school. The sophomore students

comfort level with STEM subjects decreased from the fall to spring except in Engineering and from sophomore year to senior year. 100% of the both student cohorts intend on going to college. All of the sophomores and 88% of the seniors intend on majoring in STEM subjects. Students had strong interest in certain STEM careers. Sophomore career interests changed over the academic year with Nursing, Medical Doctor and Scientist being the most popular in the spring survey. Seniors preferred the professions of Medical Doctor followed by Nursing and Mathematician. Both sophomores and seniors had a good understanding of the skills required and used in STEM fields such as problem solving, teamwork, creativity and mathematics. Senior students tended to take more advantage of the Achievement Coach services as compared to the sophomore students but this could be the result of having spent more time in the program.

First generation college students enrolled in STEM program areas of study. First generation students enrolled in STEM program areas of study at the college are markedly unengaged in student clubs/activities. Interestingly however, when asked if they would participate in clubs or activities with a defined STEM focus that are not currently available at the college, the response was very much in the affirmative (more than 64% or more for all activities listed). Most students, 54% intend on transferring to 4 year institutions. Seventy eight percent (78%) responded that they were not academically prepared for math which correlates to the high school student's survey results indicating a general disinterest in math over time.

The survey results confirm the literature that underrepresented students including first generation students have difficulty engaging in non-academic activities at college and particularly at community colleges where students tend to spend their limited time on campus attending classes and studying. The lack of student engagement at community colleges is an

important consideration, as research over the past few decades has shown that student success is positively linked to student engagement.

Recommendations

Based on the literature review, results of the student surveys and findings from the focus group discussion, recommendations include creation of a STEM LC for first generation students at the community college and enhancement of the Early College program to include more purposeful infusion of STEM activities. The specific recommendations to achieve these objectives are described in more detail below.

Recommendation 1: Retain a full time STEM LC Program Coordinator and Transition the Early College Program Manager to a Full Time, Permanent Position

The colleges' existing STEM LC Program was created under a grant program and is currently funded by the state *Vision Project*. A member of the Advising Department assumed management of the program as part of their regular advising position. There are currently two grant funded part time Achievement Coaches who provide academic and career support to the students. In order to remain a viable program, funding will need to be incorporated into the college's operating budget to institutionalize the program. This would include funding for a dedicated Program Coordinator, the part time Achievement Coaches, STEM activities, professional development opportunities, and faculty stipends.

Recent literature has suggested that one of the problems with LCs is that they are often small, isolated programs and that in order to be truly impactful; they need to be scaled up at individual institutions (Visher, M. G., Schneider, E., Wathington, H. & Collado, H., 2010). The current program is housed at only one of the two main academic campuses and should, at a minimum, be scaled up by having the program reach into both locations. The literature also

suggests that including a dedicated Program Coordinator is a key factor in bringing LCs to scale (Visher et al. 2010). The Program Coordinator would oversee all aspects of the program implementation including student and faculty recruitment, faculty development, course enrollment, coordination of Achievement Coaches, community outreach and fundraising and collaboration with other Department in the college including Admissions, Advising, Institutional Research, and Marketing.

Similarly, the Early College program is managed by a full time staff person who has other responsibilities funded under the *Vision Project* grant program which will end in two years. This position should transition to a dedicated full time position in order to support the programs efforts to scale up.

Recommendation 2: Create a STEM LC for First Generation Students at the College

One objective of this research was to design a framework for the creation of a first generation STEM LC at the community college. Creation of the proposed LC will help the college achieve several outcomes of the state's higher education *Vision Project* and meet the performance metrics contained in the state's new performance-based funding formula for community colleges. The recommendations, which are discussed in more detail below, suggest that the college's existing STEM LC be modified to serve first generation students and include targeted faculty and student recruitment plans; a more robust cohort-based thematic curriculum infused with project/inquiry based and collaborative learning and research; a summer bridge program; and tailored student support services. To ensure program success, opportunities for scaling up the program and providing faculty professional development opportunities should be included. The specific framework for the STEM LC is described below.

Modify the Existing STEM LC to Serve First Generation Students. The college already has the framework of a STEM based LC, so the first generation STEM LC program design does not need to start from scratch. Currently the program is open to women and low income minorities. First generation status is not considered. This design precludes first generation males who do not fit into these categories from participating in the program. Specific recommendations for improving the LC are provided below. The Program Coordinator should work with the coordinator of the existing LC program to determine the most effective actions that can be undertaken to modify the program to serve first generation students.

Design the Program as a Cohort Model. The STEM LC is envisioned as a cohort based curriculum that includes thematically linked courses that scaffold into a culminating research project. Introducing thematically linked courses that provide students with the colleges' general education learning outcomes including critical thinking, oral and written communication, and civic engagement would enhance the effectiveness of the LC. Thematically linked courses help students see the relationships between different academic areas and fields of knowledge. They also provide faculty with the opportunity to collaborate with other faculty members and help them develop new ideas and approaches for their own courses. According to Hesse and Mason (2005), LCs are built on the premise that learning is a social endeavor, that quality learning is enhanced by quality relationships and that the most effective LCs are those that have classrooms "where students are connected through meaningful conversations in cooperative groups with each other and with teachers." (p.1). The LC should provide collaborative assignments and opportunities for students to present and discuss projects in class.

The college embarked on a program to incorporate sustainability into the curriculum several years ago that could be used as the unifying theme for the STEM LC. Currently there are

over 50 academic courses that have infused sustainability into the curriculum. One of the courses, *Introduction to Sustainable Living*, is an interdisciplinary course co-taught by two instructors. Other courses include general education requirements some of which are STEM subjects that also fulfill general education requirements such as math and biology. These courses should be reviewed and meetings with faculty interested in participating in the LC convened to define an intentional learning framework to allow problem based and experiential learning to encourage higher level thinking and deeper learning through individual and group work to be incorporated into the program. The faculty group would also determine which courses would be most appropriately linked by the unifying theme of sustainability for the first generation STEM LC cohort. Consideration should be given to enrolling first year students into a math developmental course that includes a student success component linked to a college level course each semester. This course could be incorporated into the proposed summer bridge program that is discussed in Recommendation 3 below.

Undertake Purposeful Student Recruitment for the Program. A key to program success is effective and deliberate recruitment and retention of first generation students. The Program Coordinator should work with the Early College Program Director, the Admissions Office and area high schools to identify potential first generation students who are interested in pursuing STEM fields of study at the college. A student recruitment plan that includes targeting first generation students from the Early College programs, the college's TRIO program, social service agencies such as Girls Incorporated and the Boys and Girls Clubs, as well as other area high schools should be developed. The recruitment plan could focus on the Gateway communities located in the colleges' service area that that serve a higher population of minority and first generation populations. The college currently hosts STEM Career Days for high

school students which could be used as one means of tracking high school students who are interested in the program. Marketing materials on the STEM LC should be developed to promote the program and distributed to local high school guidance counselors and math and science teachers. The Program Coordinator should attend college sponsored guidance counselor events and other activities involving the high school population to market the program and recruit students.

Embed Tailored Student Services into the Program. In order to keep students on track and ensure student success and persistence in their STEM majors, specific student services or "micro strategies" designed for the LC need to be provided under the umbrella of the STEM LC program. These services should include peer to peer mentoring and intrusive advising. Research has shown that peer mentoring and advising are very effective tools for increasing student achievement and retention. New students can relate to their peers and benefit from the older students experiences and perspectives. According to Koring (2006), appropriately trained peer mentors/advisors are particularly helpful in teaching new students in skills in time management, goal setting and study strategies. Ideally stipends should be provided for the peer mentors. The peer mentors could facilitate study groups that would help students engage with each other in problem solving activities.

The college already provides intrusive advising activities such as the Early Warning system that notifies instructors when students are in danger of failing. This program should be incorporated into the STEM LC program and enhanced so that the Program Coordinator and Achievement Coaches have ready access to the data. Other services could include mandatory orientation at a STEM LC session, career counseling, facilitated study groups and graduation planning sessions.

Research and Internship Opportunities Should be Provided to all Program Participants. Undergraduate research and capstone experiences contribute to student success in higher education and are especially effective for underserved students (Brownell and Swaner, 2009). Including a culminating research/capstone project in the STEM LC will provide relevancy and authentic learning experiences for the students. Student research requires collaborative teamwork encourages higher order thinking skills and provides hands on and project based learning opportunities; all of which are required to be successful in STEM fields. Faculty should work with students to identify possible research projects involving outside nonprofit organizations and/or nearby four year institutions of higher education.

Providing internships in STEM fields would also provide students with hands on experiences in STEM careers and help foster their interest in their STEM academic pursuits. The Program Coordinator should work with the local workforce investment board and the Alumni Office and others at the college involved in such efforts to identify possible internship opportunities and to implement an internship program.

Faculty Should be Recruited into the Program and the College Should Provide Professional Development Opportunities to Faculty and Staff on LCs. Faculty recruitment is also very important in the formation and success of LCs. According to a recent study on six community colleges involved in scaling up LCs at their institutions (Visher et al. 2010), "recruiting and supporting enough motivated faculty were ongoing challenges at most of the institutions". Faculty participation in the STEM LC would include teaching and working with students on their capstone research projects. The LCs design would require faculty to work in teams and create connections between their courses. Professional development opportunities for faculty participating in the LC would facilitate this teaching practice. At one of the institutions

included in the Visher et al. (2010) study , a six week training module was developed for faculty who were partnering across departments to plan their LC and faculty were compensated for the training and for participating in the LC. Faculty professional development on the unique challenges posed by first generation students should be provided. Faculty should be encouraged to meet with students and provide academic advising.

Program Outcomes Assessment Should be Conducted Regularly and Should be Used to Inform the Direction of the Program. The success of the LC would advance six of the seven *Vision Projects'* key outcomes including college participation, college completion, student learning, workforce alignment, preparing citizens, and closing the achievement gap. The LC would also help the college meet the outcome metrics of the state performance-based funding by providing first generation students with the academic preparation and skills needed to persist in STEM program areas of study achieving college completion and transfer to a four year institution in the desired time frame. The STEM LC with the assistance of the Institutional Research Department should also perform an annual assessment of program outcomes. The assessment would track student persistence, GPA, meetings with Achievement Coaches, changes in majors, progressions through math coursework, participation in clubs/activities, and transfers to four year colleges.

Recommendation 3: Create a first generation STEM summer bridge program

Summer bridge programs are designed to help students make the transition from high school to college by introducing them to college expectations and experiences (Barnett and Hughes, 2010). The design of summer bridge programs varies by institution and program goals but they generally include academic courses, advising, and counseling services designed to integrate the student to the college setting and culture (Kezar, 2000). The programs usually

extend over a three to six week period (Hall, 2011). Research shows that summer bridge programs help first generation students acquire social and academic skills that help high school students transition to college. According to Barnett and Hughes (2010), "The limited research that has followed students as they enter college after participating in a summer bridge program has found positive student outcomes. Students attending summer bridge programs have been found to have higher retention rates than comparison students. In addition, research suggests that underprepared students who participate show improvement in their academic performance." (p. 62).

The focus group participants also discussed the benefits that would accrue to first generation students through the creation of a summer bridge program. The college is launching a summer bridge program this year however, it is not specifically designed for STEM or for first generation students but could serve as a model for creating a STEM based summer bridge program. The envisioned summer bridge program should include a for credit college readiness course exposing students to STEM academics and career choices as well as skills to promote academic persistence and achievement such as study skills and time management. Kezar (2000) stated that many summer bridge programs for first generation students include sessions on "the goals of a liberal arts education or general education" as well as discussions about college life (p. 2).

The Early College faculty focus group participants suggested that study skills and time management are critical to student success which was reinforced by a faculty member who emphasized that these skills are also critical in STEM fields. To address the concerns with inadequate math preparation documented by the literature, comments from the focus group participants, and student survey responses, the program should include a developmental math

course. Including some science-based laboratory and field activities would also enhance student interest in STEM subjects. According to Kezar (2000), STEM based summer bridge programs typically include "...curriculum focused on introducing lab work, understanding what it means to work in the science or math area, familiarizing them with group and problem based learning, and developing mentoring relationships" (p. 3).

Early College program students who intend on enrolling in STEM program areas of study at the college should be required to participate in the summer bridge program. The program would be based at the college which would provide students with a more authentic "college experience".

Recommendation 4: Infuse More Purposeful STEM Activities into the Early College Program

The survey results show that most high school students are interested in pursuing STEM majors in college and are interested in STEM careers. While the existing Early College program provides some STEM exposure through field trips and a summer Environmental Science course, these activities could be supplemented by adopting STEM based curriculum into the program such as Project Lead the Way (a high school curriculum that uses engineering, science, math, and technology to solve complex, open-ended problems in a real-world context). This would require the Early College Project Director to work closely with the high school staff involved in the Early College program to devise an implementation strategy over time.

Another means to enhance STEM teaching involves providing professional development opportunities for high school teachers in project based STEM teaching and learning such as those offered by Worcester Polytechnic Institute. The Early College staff at the college could assist the high school administration in identifying the best professional development opportunities and

encouraging faculty to participate in these events. The Project Director could work with the Achievement Coaches and students to create a STEM club and a STEM mentors program. The existing LC STEM club at the college could provide a possible source of mentors for the high school students.

Regularly scheduled STEM related activities such as field trips and Career Days would also improve the STEM exposure for these students. The Early College program is expanding into another high school in the City next year. The City may want to consider assigning a staff person to coordinate with the college's Early College Project Director to help facilitate these program improvements. Enhancing the Early College program could create a pathway to the recommended summer bridge and first generation STEM LC programs at the college.

Another refinement to the Early College program involves lengthening the course schedule for the Environmental Science Course which is held in the summer at the college campus. The faculty member who taught the course recommended that the course be spread out for a longer time frame to reduce students heavy work load. The course engaged students through group work, brainstorming activities to solve problems, and student-led discussions on environmental issues of local significance (e.g. high bacteria counts on Lynn beaches, waste from overconsumption of plastic bottles, & exposure to BPA). The students found these activities very engaging and should be in the course curriculum. According to the faculty member who taught the Environmental Science class, success in the STEM subjects increases students' confidence in general. To enhance student competency in STEM subjects, the professor suggested that a Biology 101 course could be added to the program to expose students to laboratory experience which is relevant to many STEM careers.

Conclusion

This research project confirms the findings of other academic research that first generation students enrolled in STEM majors would benefit from participation in a summer bridge and a STEM LC program. By their cohort nature, LCs provide a sense of community, peer support and increased faculty/student engagement which are linked to student success and first generation students. Olson and Labov (2012) in their summary of a national summit on the role of community colleges in STEM education, concluded that "To facilitate and increase the transfer of underrepresented students in STEM to four-year institutions, increased emphasis and support are needed for articulation agreements, summer bridge programs, mentoring, academic and career counseling, peer support, tutoring, social integration activities, study groups, undergraduate research, and tracking of student progress." (p. 14-15).

The state *Vision Project* endorses high impact educational practices such as LCs which provide students with the social and academic skills necessary to succeed. The state has also recently adopted performance-based funding and community colleges must now demonstrate performance in terms of student academic achievement and persistence. LCs can be used to increase student engagement which results in academic achievement and persistence.

Recent research on LCs at community colleges suggests that in order to be effective these programs need to be scaled up which involves retaining a paid coordinator, ensuring that the program expectations are clearly articulated, ensuring that faculty receive necessary support to link and integrate courses and ensuring that the appropriate student support services are provided**.** The college has an existing STEM LC that could and should be scaled up as described in this paper in order to increase academic achievement and persistence of first generation students and to increase their representation in high demand STEM fields.

This study confirms the findings of previous research regarding the challenges faced by first generation students pursuing post-secondary education in STEM majors. The study survey of high school students enrolled in an Early College program demonstrated that while students are interested in STEM careers and may plan on pursuing STEM majors in college, they are often underprepared academically and socially to achieve these goals. The survey of college students enrolled in STEM program areas of study confirmed research that shows that first generation students struggle to become engaged in college which can interfere with academic success and persistence. The suggested redesign of the colleges STEM LC to focus on first generation students will address these issues through the cohort model infused with tailored student support systems designed to help the students achieve their academic and career aspirations.

LCs are designed to provide students with the democratic foundations and the knowledge and skills needed to become responsible citizens of the world. LCs engender a sense of civic responsibility that benefit underrepresented students. According to Tinto (2003), students participating in LCs and similar programs report an increased sense of responsibility to participate in the learning experience, and an awareness of their responsibility for both their learning and the learning of others. "By learning together, everyone's understanding and knowledge was, in the eyes of the participants, enriched." (p. 5).

There is a high demand for STEM skilled workers in the United States and there are not enough skilled workers to satisfy the demand. According to Bragg et al, (2006), "Community colleges play an important role in expanding access to college by enrolling students who are members of ethnic minority groups or who are low income, first generation, or underprepared for college-level work." (p. 6). Women and minorities are underrepresented in STEM fields which

have relatively high paying career tracks. By instituting high impact educational practices such as LCs that target first generation students interested in pursuing STEM fields, community colleges can address both of these issues and also achieve their long-standing social justice mission of providing educational access, opportunity and success for all citizens.

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